Investigation of Long-Term Impacts of Urbanization when Considering Global Warming for a Coastal Tropical Region

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The overachieving goal of this project is to gain a better understanding of the climate impacts caused by the combined effects of land cover and land use (LCLU) changes and increasing global concentrations of green house gases (GHG) in tropical coastal areas, regions where global, regional and local climate phenomena converge, taking as the test case the densely populated northeast region of the Caribbean island of Puerto Rico. The research uses an integrated approach of high-resolution remote sensing information linked to a high resolution Regional Atmospheric Modeling System (RAMS), which was employed to perform ensembles of climate simulations (combining 2-LCLU and 2-GHG concentration scenarios). Reconstructed agricultural maps are used to define past LCLU, and combined with reconstructed sea surface temperatures (SST) for the same period form the PAST climate scenario (1951-1956); while the PRESENT scenario (2000-2004) was additionally supported by high resolution remote sensing data (10-m-res). The climate reconstruction approach is validated with available observed climate data from surface weather stations for both periods of time simulated. The selection of the past and present climate scenarios considers large-scale biases (i.e. ENSO/NAO) as reflected in the region of interest.

Direct and cross comparison of the results is allowing quantifying single, combined, and competitive effects. Results indicate that global GHG have dominant effects on minimum temperatures (following regional tendencies), while urban sprawl dominates maximum temperatures. To further investigate impacts of land use the Bowen Ratio and the thermal response number (TRN) are analyzed. The Bowen ratio indicates that forestation of past agricultural high areas have an overwhelmingly mitigation effect on increasing temperatures observed in different LCLU scenarios, but when abandoned agricultural lands are located in plains, the resulting shrub/grass lands produce higher surface temperatures. The TRN (J/m^2/degC) is a surface property defined as the ratio of the surface net radiation to the rate of change in surface temperature, expresses how those fluxes are reacting to radiant energy inputs. Natural vegetated surfaces have a greater TRN than urban and barren surfaces because the net radiation processed by them is mostly used for latent heat and thermal storage heat rather than sensible heat (heating the air). Significant changes in TRN were observed in the metropolitan area of San Juan for the two analyzed periods reflecting a reduction of this variable in the present from the past consistent with increasing in thermal mass, or intense urbanization.

9th Symposium on the Urban Environment, sponsored by the American Meteorological Society
August 2-6, 2010
Keystone, CO